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CLONAL VARIATION IN WESTERN WHITE PINE. I. GRAFTABILITY

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ABSTRACT

Periodic observations on ramets of 13 western white pine clones show that individual trees vary in graftability. The type or degree of stock-scion incompatibility leading to poor grafting results also varies and may appear soon after grafting or years later. Detection of long-term incompatibility is not now possible. Survival of ramets appears to be related to vigor of ortets.

Vegetative propagation by grafting has been a useful technique in many forest tree improvement programs. An understanding of stock-scion relations, and particularly graft incompatibility, is therefore essential to assure immediate or long-term success with grafts.

Incompatibility is especially evident in a species that is relatively difficult to graft, such as western white pine (Pinus monticola Dougl.) The performance of 3,250 grafts, representing 13 clones of this species, has been observed during 2 years following grafting. The results indicate that clones differ in graftability. Some factors relevant to the success or failure of pine grafts are also pointed out in this study.

The apparent causes of incompatibility have been discussed and reviewed extensively over a period of at least 30 years.[2] [3] Some of the more common factors mentioned are stock-scion union failure, abnormal development of bud or scion after some union has occurred, imperfect union of vascular tissues, virus infections, and others. Since two different genotypes are involved, each possessing different physiological and morphological characteristics, it is not surprising that incompatibilities result Why this situation prevails in some species more than in others is not known.

Stock-scion incompatibility in trees may not express itself until many years after union is made.[4] This indicates that some types of incompatibility are associated with aging of the plant; this factor obviously would be important in grafted seed orchards. Unfortunately, the detection of this long-term incompatibility is now impossible.

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[2] Rogers, W. S., and A. Beryl Beakbane. Stock and scion relations. Ann. Rev. Plant Physiol. 8: 217-236. 1957.

[3] Roberts, R. H. Theoretical aspects of graftage. Bot. Rev. 15: 423-463. 1949.

[4] Rogers and Beakbane, op. cit., p. 225.

MATERIALS AND METHODS

These observations were made in connection with establishment of an experimental western white pine seed orchard. Thirteen trees were chosen as ortets, based on the above-average performance of their progeny in resistance to the blister rust disease caused by *Cronartium ribicola* Fischer. In late November 1958 sufficient scionwood to produce 250 grafts was taken from each tree, packed in snow and wrapped in polyethylene film, and then frozen until used.

Stock plants were ordinary, and presumably nonresistant, 4- and 5-year-old nursery seedlings. Most of them were established in pots one season prior to use; then after the onset of freezing weather and dormancy, were moved into a 70° greenhouse on a 16-hour photoperiod until terminal growth was well advanced.

Grafting of the 3,250 trees began in January 1959 and was completed in about 3 weeks. The bottle graft methods was used exclusively. Past experience has shown that without an external source of water, death of the scion was highly likely in western white pine because of the long time apparently necessary to establish a union between stock and scion. Currently, efforts at Moscow are directed toward developing a more efficient field grafting procedure to replace the bottle graft technique, and some encouraging results have been obtained with a whip and tongue graft. In the present study no grafting wax was used since pitch sealed cut surfaces quickly. The stock-scion union was maintained by wrapping with rubber budding bands.

Completed grafts were held in the greenhouse until June 1959; then they were moved out of doors under half-shade for the summer. On November 2, 1959, after the onset of freezing weather, the grafts were returned to the greenhouse, where they remained at 70° on a 16-hour photoperiod until February 9. They were then hardened off by dropping the temperature, in steps, to about 35° F. and until refrigerator trials showed that plants could withstand overnight exposure to 25° F. temperatures. They were then outplanted at Sandpoint, Idaho, in April 1960. Each graft was observed 4, 9, and 20 months after grafting. Survival, character of union, and growth of scion were recorded.

Throughout the period of observation, from grafting to outplanting, all 13 clones were treated as uniformly as possible to restrict variation in graftability to differences between ortets.

Table 1.--Ranking of western white pine ortets by scion mortality and percent of ramets showing scion growth during first season

Ortet no.	Ortet elevation	Vigor class[1/]	Crown location of scion	Scion survival ranking by ortets							
				4 months		9 months		20 months		Growth field, 1960	
	Feet			Pct.	Rank	Pct.	Rank	Pct.	Rank	Pct.	Rank
17	3,100	Good	Mid.-Low	90	3	77	5	58	2	51	6
19	3,000	Poor	Low	88	4	70	9	40	10	29	8
22	3,100	Poor	Mid.-Low	82	7	79	4	52	5	74	2
24	3,000	Good	Mid.-Low	78	10	72	7	50	7	57	5
25	3,200	Poor	Random	66	11	61	11	39	11	37	7
37	2,950	Poor	Mid.-Low	62	12	56	12	30	13	26	9
54	5,000	Good	Random	88	5	84	3	52	6	16	11
58	3,000	Good	Low	93	2	88	2	72	1	83	1
63	5,000	Good	Random	82	7	75	6	52	4	13	13
65	3,100	Good	Mid.-Low	85	6	72	7	58	2	68	3
69	5,000	Poor	Random	97	1	92	1	46	8	20	10
103	4,200	--	Mid.-High	80	9	70	9	42	9	57	4
150	3,520	--	Random	55	13	52	13	34	12	14	12

[1/] Vigor ratings were based on mean annual growth rates adjusted for differences in site and age. The "good" and "poor" classifications distinctly separated the trees on this basis.

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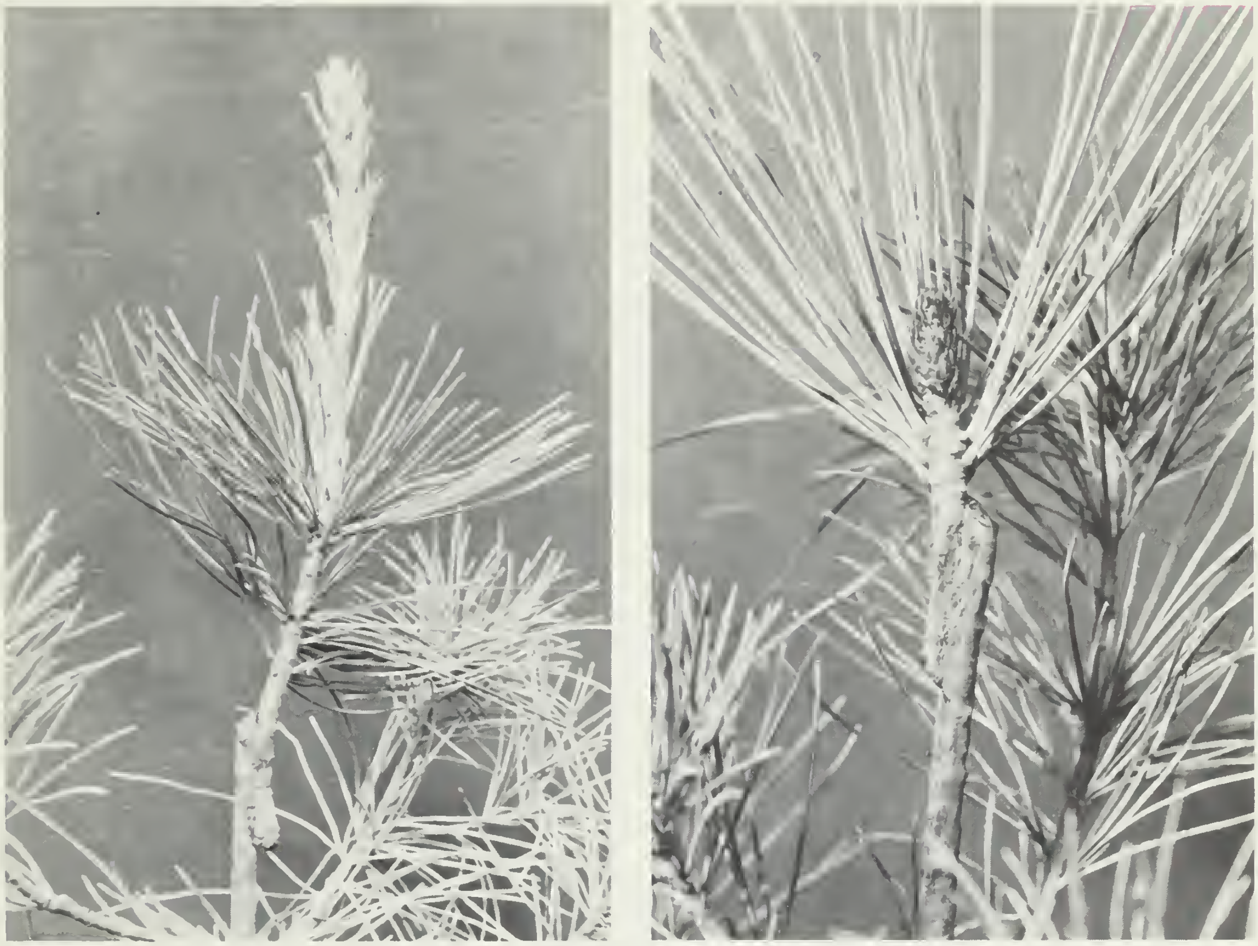

Figure 1.--Western white pine grafts 12 months after grafting showing typical good (left) and poor (right) growth of scions. In both grafts, union is apparently normal.

RESULTS AND DISCUSSION

Percent of survival was calculated for each clone at the three observation times (table 1). The percentage of surviving trees having measurable scion growth 20 months after grafting (5 months after outplanting) was also determined.

The data do not lend themselves to statistical analysis, but they do show some interesting relations. First, the 13 ortets tested represent a range of stock-scion incompatibility systems. The relatively good success in grafting trees 58 and 65, compared with that of trees 37, 150, and 25, suggests the need for selecting suitable ortets whenever possible when clonal propagation of western white pine is necessary. The consistently poor performance of clones 37, 150, and 25 considerably increases the cost of grafting with such trees.

The performance of clone 69 is an example of apparent initial success followed by poor survival over a longer period of time. For a long time ramets of this clone maintained green foliage, sound buds, and some union; but when subjected to the stresses of winter and transplanting, incompatibility appeared.

Clone 63 ranked high in survival but performed poorest in actual growth after transplanting. This clone evidently can establish a good stock-scion union, but whether the scion can grow during subsequent years remains to be seen. It may be that growth of scion from tree 63, which was of high elevation origin, was restricted by some environmental factor. However, F_1 progenies of tree 63 are also very slow growing. The other high elevation clones, 54 and 69, also performed poorly in growth during the first season under orchard conditions.

If we consider survival only, the range of ortet elevations represented in this study apparently had little effect; neither did position in the crown from which scions were obtained. The latter is interesting, considering recommendations by some that in certain species scionwood should be collected from the upper portions of the crown. First- and second-ranked clones 58 and 65 were grafted entirely from scion cut very low on the tree; so was the last-ranked clone, 37. Ortet vigor apparently influenced the average survival of its ramets as shown by the higher survival rates for the good- in comparison with the poor-vigor trees.

After 4 months the graft union of each dead scion was examined and rated for degree of union between joined surfaces of stock and scion. Results showed that, although most stock-scion unions were spotty or nonexistent, many were considered very good, particularly on incompatible clones 25, 37, and 150. This indicates that the ability to form callus tissue and some tissue union is not lacking in incompatible trees, and provides more evidence that incompatibility factors may be active at each stage in the development of stock-scion unions.

CONCLUSIONS

1. Individual western white pine trees show considerable variation in graftability.

2. Different degrees or types of early incompatibility appear in western white pine.

3. Incompatibility may appear in spite of initial success in grafting.

4. Such factors as ortet elevation and height in the crown from which scionwood is collected seem to have negligible influence on white pine graft survival during the first 2 years. Ortet vigor did appear to contribute to average survival of its ramets.